

WHAT IS CLAIMED IS:

1 1. A method of producing a physiological response in an animal comprising
2 administering to the animal a metal-containing nucleic acid duplex, wherein the metal-
3 containing nucleic acid duplex comprises a first strand of nucleic acid and a second strand of
4 nucleic acid, the first and the second nucleic acid strands each comprising a plurality of
5 nitrogen-containing aromatic bases covalently linked by a backbone, the nitrogen-containing
6 aromatic bases of the first nucleic acid strand being joined by hydrogen bonding to the
7 nitrogen-containing aromatic bases of the second nucleic acid strand, the nitrogen-
8 containing aromatic bases on the first and the second nucleic acid strands forming hydrogen-
9 bonded base pairs in stacked arrangement along the length of the metal-containing nucleic
10 acid duplex, at least some of the hydrogen-bonded base pairs comprising an interchelated
11 divalent metal cation coordinated to a nitrogen atom in one of the aromatic nitrogen-
12 containing aromatic bases.

1 2. The method of claim 1, wherein the physiological response is an immune
2 response.

1 3. The method of claim 2, wherein the metal-containing nucleic acid expresses
2 an antigenic protein in the animal to produce the immune response.

1 4. The method of claim 2, wherein the immune response produces antibodies to
2 the metal-containing nucleic acid in the animal.

1 5. The method of claim 1, wherein the physiological response is an antisense
2 response, wherein expression of the metal-containing nucleic acid inhibits the expression of
3 a complementary gene, wherein the complementary gene has a sequence complementary to
4 the first or second strand of the metal-containing nucleic acid.

1 6. The method of claim 1 wherein the first and the second nucleic acid strands
2 are deoxyribonucleic acid and the nitrogen-containing aromatic bases are selected from the
3 group consisting of adenine, thymine, guanine and cytosine.

1 7. The method of claim 1 wherein the divalent metal cation is selected from the
2 group consisting of Zn^{2+} , Co^{2+} , and Ni^{2+} .

1 8. The method of claim 1 wherein the divalent metal cations are substituted for
2 imine protons of the nitrogen-containing aromatic bases, and the nitrogen-containing
3 aromatic bases are selected from the group consisting of thymine and guanosine.

1 9. The method of claim 1 wherein at least one of the aromatic nitrogen-
2 containing aromatic bases is thymine, having an N3 nitrogen atom, and the divalent metal
3 cation is coordinated by the N3 nitrogen atom.

1 10. The method of claim 1 wherein at least one of the aromatic nitrogen-
2 containing aromatic bases is guanine, having an N1 nitrogen atom, and the divalent metal
3 cation is coordinated by the N1 nitrogen atom.

1 11. The method of claim 1, wherein the metal-containing nucleic acid further
2 comprises an electron source electrically coupled to the metal-containing nucleic acid
3 duplex.

1 12. The method of claim 11, wherein the metal-containing nucleic acid further
2 comprises an electron sink electrically coupled to the metal-containing nucleic acid duplex.

1 13. The method of claim 1, wherein the animal is a human.

1 14. A method of producing a physiological response in an animal comprising
2 administering to the animal a metal-containing nucleic acid duplex, wherein the metal-
3 containing nucleic acid duplex is made by a process comprising:
4 a) providing a nucleic acid duplex comprising a first strand of nucleic
5 acid and a second strand of nucleic acid, the first and the second nucleic acid strands
6 comprising a plurality of nitrogen-containing aromatic bases covalently linked by a
7 backbone, the nitrogen-containing aromatic bases of the first nucleic acid strand being joined
8 by hydrogen bonding to the nitrogen-containing aromatic bases of the second nucleic acid
9 strand, the nitrogen-containing aromatic bases on the first and the second nucleic acid

10 strands forming hydrogen-bonded base pairs in stacked arrangement along the length of the
11 nucleic acid duplex; and,
12 b) subjecting the nucleic acid duplex to a basic solution in the presence
13 of a divalent metal cation under conditions effective to form a conductive metal-containing
14 nucleic acid duplex, wherein at least some of the hydrogen-bonded base pairs of the
15 conductive metal-containing nucleic acid duplex comprise an interchelated divalent metal
16 cation coordinated to a nitrogen atom in one of the aromatic nitrogen-containing aromatic
17 bases.

1 15. The method of claim 14, wherein the physiological response is an immune
2 response.

1 16. The method of claim 15, wherein the metal-containing nucleic acid expresses
2 an antigenic protein in the animal to produce the immune response.

1 17. The method of claim 15, wherein the immune response produces antibodies to
2 the metal-containing nucleic acid in the animal.

1 18. The method of claim 14 wherein the first and the second nucleic acid strands
2 are deoxyribonucleic acid and the nitrogen-containing aromatic bases are selected from the
3 group consisting of adenine, thymine, guanine and cytosine.

1 19. The method of claim 14 wherein the divalent metal cation is selected from the
2 group consisting of Zn^{2+} , Co^{2+} , and Ni^{2+} .

1 20. The method of claim 14 wherein the divalent metal cations are substituted for
2 imine protons of the nitrogen-containing aromatic bases, and the nitrogen-containing
3 aromatic bases are selected from the group consisting of thymine and guanosine.

1 21. The method of claim 14 wherein at least one of the aromatic nitrogen-
2 containing aromatic bases is thymine, having an N3 nitrogen atom, and the divalent metal
3 cation is coordinated by the N3 nitrogen atom.

- 1 22. The method of claim 14 wherein at least one of the aromatic nitrogen-
2 containing aromatic bases is guanine, having an N1 nitrogen atom, and the divalent metal
3 cation is coordinated by the N1 nitrogen atom.